The Influence of Amaferm on Swine Breeding Performance

Thesis

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By

Melinda Blake Hess

The Ohio State University

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Project Advisor:

Dr. Steven Moeller

Abstract

The dietary addition of a prebiotic, like *Aspergillus oryzae*, to the standard feed of many species has been reported to have positive effects on the digestibility of fiber and in turn improved animal efficiency and nutrient uptake of the animal. In this study thirty-six commercial cross bred breeding females, in two replications of 18 females each were used to evaluate the effects of the addition of Amaferm, *Aspergillus oryzae*, to their diet. Females were randomly and in equal number allocated at approximately day 70 of gestation within replication to two treatment groups: Control or Amaferm. All females received a standard corn-soy bean meal of the same amount. The Amaferm treatment group received a standard daily dose of 45 g/day of Amaferm to supplement their diet. Sow weight, back fat depth, and body condition score were measured to evaluate the performance of the sow and the effectiveness of Amaferm. Colostrum and milk samples were also collected and evaluated for IgA, IgM, and IgG concentrations using an ELISA assay. Number of piglets in a litter and piglet weight were measured. All results were analyzed using a mixed model procedure of SAS. A P value of <0.05 was considered statistically significant. The results of the present study showed no significant difference between the control and Amaferm supplemented diets for the sow factors, immunoglobulin concentrations, or for the litter. Trends for sow weight, and piglet growth was normal. The Amaferm treatment group lost less weight after farrowing than the control group, which may suggest improved nutrient utilization from the Amaferm diet and the ability to minimize weight loss and maintain body condition score. All immunoglobulin concentrations were higher than previously reported

values except for day 14 and day 21 IgG levels. Further research on multiple parity effects and the dosage of Amaferm is needed to determine the effectiveness of Amaferm as a prebiotic feed additive.

INTRODUCTION

Breeding age pigs, and pigs in general, have a limited ability to digest fiber in their diets because they are mono-gastric animals. Dietary additives that can improve digestibility of fibrous portions of a standard corn-soybean meal diet or alternative, high fiber feedstuffs fed to swine may improve measures of efficiency, including feed conversion, growth rate, reproduction and longevity. Improved digestibility should lead to increased nutrient uptake and the opportunity to distribute these nutrients for body maintenance, growth, reproduction and lactation purposes. The commercially available prebiotic Amaferm is an extract of a non-pathogenic strain of the fungus *Aspergillus oryzae.* This fungus is considered a prebiotic because it is an organic compound that cannot be digested in the foregut of swine, but can be digested by the microbial population in the hindgut of pigs. (Callaway, T. R., et al.) Improving intestinal microbial populations and gut health may lead to improved nutrient digestibility, offering a significant opportunity for the inclusion of higher fiber, lower cost dietary ingredients as energy sources in swine diets while maintaining or improving performance.

Aspergillus oryzae has been evaluated as a dietary additive in ruminant animals and it has been demonstrated that *Aspergillus oryzae* can improve fiber digestibility, resulting in improved feed conversion efficiency and an improved growth rate. The enhanced performance in ruminant animals has been achieved as a result of Amaferm's primary mode of action, which is to enhance the density and growth of favorable microbes in the digestive tract. Favorable microbes in the digestive tract result in greater fiber digestion from the available feedstuffs. (Yoon, I. K., and M. D. Stern.)

The addition of *Aspergillus oryzae* to the diet of growing broilers, a mono-gastric species, has been shown to increase average daily feed intake and average daily gain. The growth promoting activity from the addition of *Aspergillus oryzae* in broilers is thought to be largely due to a greater supply of essential amino acids and other vitamins and minerals. (Feng, J., X. Liu, Z.r. Xu, Y.y. Liu, and Y.p. Lu.) Literature reports supporting the effects of feeding Amaferm to growing and breeding age swine are limited; therefore, studies to evaluate the effects are necessary. Improved digestibility of a standard corn-soybean meal based diet has implications in the breeding animal and offspring through a number of potential avenues. Of interest is the influence of feeding Amaferm on the sow's body condition, the quantity and quality of her milk, and the health and growth of her offspring.

The overall objective of the present study is to assess the influence of feeding a standard dosage of Amaferm to the pregnant swine-breeding female from mid gestation in parity one through confirmation of pregnancy for parity three, measuring the sow, the quality and quantity of her milk, and her piglet performance. Specifically, measures focused on the individual female body traits (body weight changes, body condition scores, back fat depth, loin depth, and rebreeding interval), lactation milk quality attributes (IgA, IgM, IgG), and litter traits (piglet number &

piglet weight) that define breeding herd efficiency and longevity. The hypotheses for the present study are: 1) the addition of Aspergillus oryzae to the diet of swine will improve the digestibility of the fiber in the diet, which will be result in improved measures of individual performance including maintenance of improved body condition, weight and composition at all stages in the breeding cycle; and 2) improved body condition of the sow, as a result of greater nutrient availability, will improve milk quality characteristics (increase the concentration of immunoglobulin in the colostrum and milk) enhancing piglet survivability and growth rate. Data from parity one is assessed in the present study.

Materials and Methods

Pigs and Supplementation:

Thirty-six pregnant commercial crossbred (½ ToPig maternal × ½ PIC maternal) crossbred breeding females, in two replications of 18 females each, were randomly and in equal number allocated at approximately day 70 of gestation within replication to a standard corn-soybean meal diet (Control, CON) or the standard corn-soybean meal diet supplemented with Amaferm at a daily dose of 45 g/day (Amaferm, AM) per manufacturer specifications. (BioZyme Inc.) Amaferm was fed as a daily top-dress addition to the standard control diet. Daily feed allocations were 1.95 kg/day through day 110 of gestation and increased to 2.27 kg/day to day of farrowing. After farrowing sows were fed a step-up diet plan at 1.8 kg/day at farrow (D1), 3.6 kg the day after farrow (D2), and 5.4 kg the third day after farrow (D3) with ad libitum access from day four (D4) to wean at an average of 21 days. Sow weight, ultrasonic last rib back fat thickness and loin depth, and body condition score (BCS) were assessed on days 70 and 109 of gestation, at farrowing, and days 7, 14, and approximately day 21 (weaning) post-farrowing. Samples of colostrum were collected within 24 hours of farrowing (day 0) and milk samples were collected on days 14 and 21 of lactation.

IgG, IgA, and IgM Assessment Procedures:

Colostrum and milk samples were evaluated by the use of commercially available kits for swine: Pig IgA ELISA Quantitation Set; Bethyl Laboratories Cat. No. E100-102, Pig IgM ELISA Quantitation Set; Bethyl Laboratories Cat. No. E100-100, Pig IgG ELISA Quantiation Set; Bethyl Laboratories Cat. No. E100-104. Colostrum and milk samples were diluted in order to fit the four-parameter logistics curve set by the standards. The dilution for each immunoglobulin was as follows: 1:60,000 for IgA and IgM, and 1:600,000 (day 0), 1:300,000-1:100,000 (day 14 and 21) for IgG. IgG had a variety of dilutions due to the high levels of IgG in colostrum and the drastic change in IgG from colostrum to milk. Samples were run in duplicate for each ELISA. All duplicate values were within 10% of each other.

Data Analysis:

Statistical analyses were performed using mixed model procedures of SAS (SAS V9.3, SAS Institute, Cary, NC). Dependent variables were assessed in a model with treatment (CON vs. AM) as a fixed effect and replicate (n=2 replicates) as a random effect. A linear covariate for number of pigs allowed to nurse on day 3 following farrowing was used to adjust CON and AM litter data to a constant basis when comparing piglet survival (day 7, 14 and 21 number of pigs per litter) and litter weight (day 7, 14, and 21 litter weight). Interactions between treatment and replicate were tested, found not significant, and were removed from final models. Least squares means and standard errors were estimated. Statistical significance was established at $P < 0.05$.

Results

<u>*Sow data:*</u>

Sow weight was monitored from day 70 of gestation up to weaning of the first litter. Random allocation at initiation of the trial resulted in similar live body weight across treatments. Sows within the control group numerically weighed slightly more than the treatment group but there was no significant difference as shown in **Figure 1**. To account for numerical differences in live body weight across treatments, the change in weight of the sows was calculated as the change from farrowing to day 7, 14, and 21(weaning). Body weight was reduced (**Figure 2**) as expected from farrowing to weaning, and results indicate that the Amaferm treatment group had numerically less change in body weight, but there was no significant difference between the change in weights of the control and treatment groups.

Last rib backfat depth (**Figure 3**) of the AM treatment group was numerically greater than that of the control treatment except for day 7 after farrowing. Backfat measurements decreased gradually from day 70 of gestation to weaning for both the AM and CON groups, an indication that the sows were placing additional energy into the fetal development pre-farrowing and milk production post farrowing. Body condition score (**Figure 4),** where a desired optimum is a score of 3, was not different at any time point, but did decline on average as would be expected throughout lactation, when body reserves are mobilized for the production of milk.

Colostrum and Milk Analyses Results:

Milk samples from day 0 (farrowing), 14, and 21(weaning) were analyzed for IgA, IgM, and IgG. Due to issues with data collection on the farm, day 7 samples were not complete and were not included in the data set. Concentration of IgA at defined intervals (**Figure 5**) were numerically greater in the AM treatment group on days 14 and 21 but not in colostrum at day 0, but differences were not significant. IgM concentrations were numerically greater but not significant in the CON group at day 0 and day 21, but not day 14 (**Figure 6**). Concentrations of IgG were consistently greater in the CON group, but there was no significant difference between CON and AM groups.

Litter data:

Number of piglets born alive was not different across treatment groups. Adjusted to a common number of pigs allowed to nurse at day 3, sows fed AM tended to have a greater number of pigs nursing at days 7, 14, and 21 (weaning) (**Figure 8**). Litter weight increased over time as expected. Litter weight was almost identical for day 0 (birth), 3, and 7 for CON and AM groups. At day 14 and 21, the AM group produced numerically, but not significantly, heavier litter weight than the CON (**Figure 9**).

Discussion

The use of prebiotics and other natural feed additives in the food animal industry has been increasing as a way to improve animal health and in turn improve animal efficiency. The health and the production of the sow can be directly related to the nutrition that the sow receives from her diet. It is thought that Amaferm, *Aspergillus oryzae*, will increase the fiber digestion of the sow which in turn will improve the health of the sow and will have a positive effect on the growth of the piglets that she gives birth to. The addition of *Aspergillus oryzae* has shown positive effects on digestion and improved animal health in cows and chickens. (Yoon, I. K., and M. D. Stern.) (Feng, J., X. Liu, Z.r. Xu, Y.y. Liu, and Y.p. Lu)

In the present study, the observed change in sow weight was normal within the production cycle; the sows gained weight during gestation and lost weight during lactation. In a previous study the addition of Amaferm to a high fiber sow gestation diet resulted in increased weight gain in gestation, presumably due to increased nutrient availability within the high fiber diet. However, when the sows were subsequently fed a standard energy diet without added Amaferm in lactation, the sows lost more weight in lactation when compared with sows that were never fed Amaferm in gestation. (Danielsen, V., and Ellen-Margrethe Vestergaard.) In the present study, sows remained on Amaferm throughout gestation and lactation, and the sows fed Amaferm gained weight in gestation similar to the Control treatment, but had a tendency to lose less weight in lactation, a finding that may suggest improved nutrient utilization from the diet and the ability to minimize weight loss and maintain a more desirable BCS at the end of lactation. Specifically, sows that received Amaferm did not see a decrease in their BCS until day 14 while the control

BCS was reduced at day 7 of lactation. The implications of improved BCS and reduced body weight loss are generally observed in subsequent reproduction performance. Unfortunately, the data to support this suggestion are not yet available for inclusion in the present study.

Overall, the immunoglobulin concentrations in sow colostrum and milk observed in the present study were greater than reports from previous studies for both the control and Amaferm treatment groups. Milk IgG levels from the present study was the only level that represented the normal ranges presented in previous studies. (Curtis, Jill, and F.j. Bourne.) (Tizard, I.) The concentration range of IgA in the present study for the control group was 824.6 mg/dl to 2195.6 mg/dl. Previous research reported normal IgA concentrations to be between 950 mg/dl and 1050 mg/dl and between 300 mg/dl and 700 mg/dl for colostrum and milk, respectively. (Tizard, I.) Amaferm treatment group IgA concentrations were within a similar range as the control group. The concentration range of IgM in the current study for the control group was 576.3 mg/dl to 1683.9 mg/dl, levels much greater when compared to reports of 250 to 320 mg/dl and 30 to 90 mg/dl for colostrum and milk, respectively. (Tizard, I.) Average IgG colostrum levels in the present study were 11,112 mg/dl and 10,496 mg/dl for CON and AM treatment groups, respectively, values that were much greater than the range of 3000 to 7000 mg/dl that have previously been reported. (Tizard, I.) Milk concentration for IgG found in the present study were within previously reported normal ranges of 100 mg/dl to 300 mg/dl. Further research is needed to determine why the immunoglobulin concentrations were higher than the normal ranges that were expected.

Trends for litter weight changes of the piglets were normal. Litters of piglets in both the control and Amaferm treatment groups gradually gained weight from birth to weaning. It should be noted that piglets were not fed the Amaferm treatment, but their mothers were, thus piglet weight change is a function of maternal ability (i.e. milk quantity and quality). The emerging trend for litters from AM treated sows to have greater litter weight (i.e. more weight produced per pig and per sow) is encouraging and a reason to expand the number of sows used in future studies.

Of note, in a previous study, he effects of *Aspergillus oryzae* fermentation extract on the in vitro fermentation of amino acids, bermudagrass and starch by mixed rumen microorganisms in vitro showed that high levels of Amaferm (1.0 g/liter) had a detrimental effect on the digestion of some feedstuffs. (Martin, S. A., and D. J. Nisbet.) In the present study Amaferm was fed at the manufacturer labeled inclusion level; therefore, additional research may wish to be conducted to determine what is the optimal Amarferm level to improve hindgut digestion in the pig.

Implications:

The results of the present study showed no significant difference between the control and Amaferm supplemented diets for the sow factors (weight, change in weight after farrowing, back fat depth, body condition score, and immunoglobulin concentrations of IgA, IgM and IgG in the colostrum and milk) or for the litter (number of piglets per litter and litter weight). The findings of the present report only encompass one parity and represent a relatively small number of samples per treatment. The effects of Amaferm may not be seen until it is fed over the gestation and lactation phases of multiple parities. Further research on multiple parity effects and the dosage of Amaferm is needed to determine the actual effectiveness of Amaferm as a prebiotic feed additive.

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Figures:

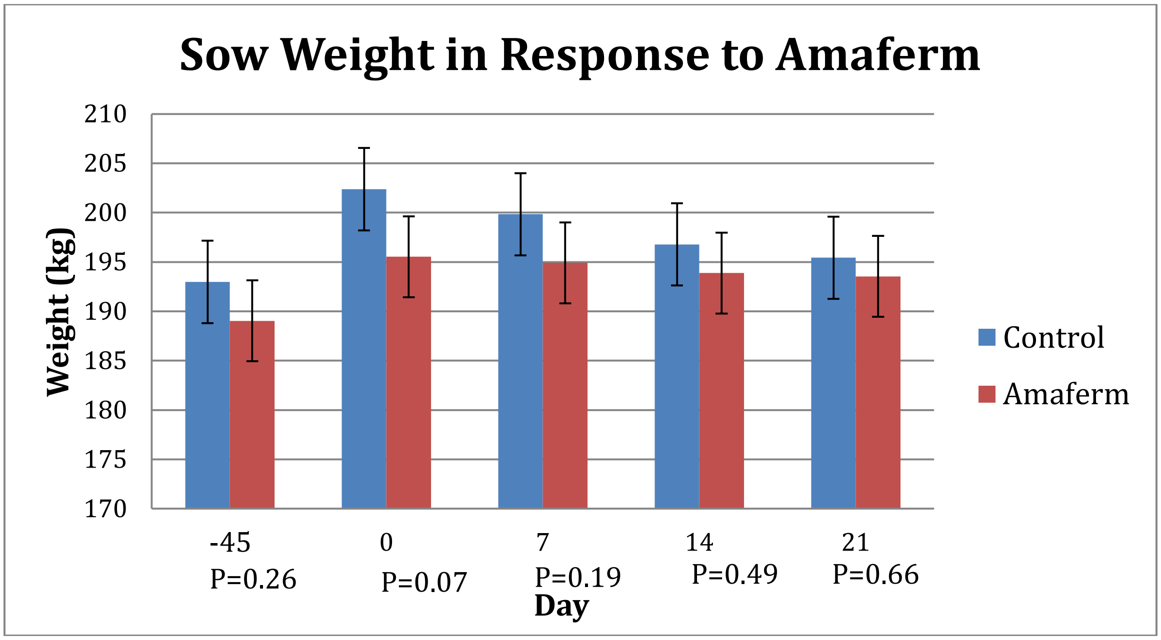

Figure 1: Comparison of sow weight in kg between control and Amaferm supplemented sow diets from day 70 of gestation (-45) through day 21 (weaning). Day 0 is day of farrowing. Bars represent least squares means ± SE.

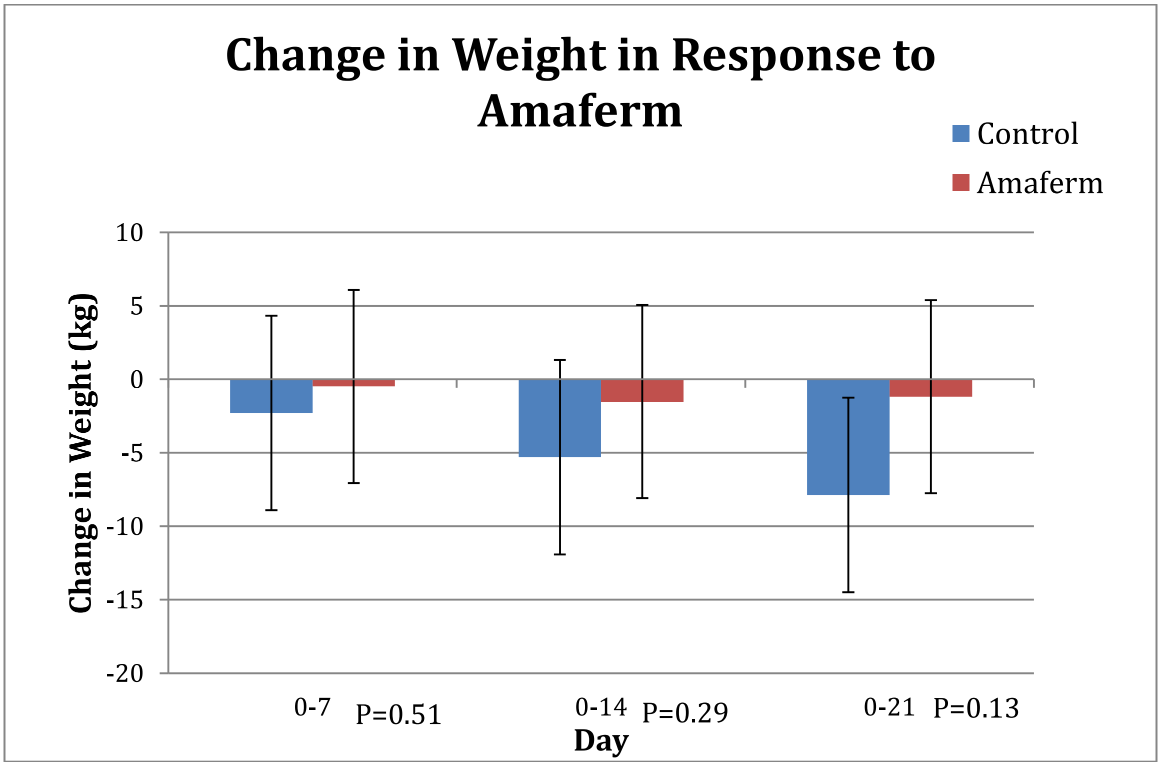

Figure 2: Comparison of the changes in sow weight in kg between control and Amaferm supplemented sow diets after farrowing. 0-7 is change in weight from farrowing to seven days after farrowing, 0-14 is change in weight from farrowing to 14 days after farrowing, and 0-21 is change in weight from farrowing to 21 days after farrowing (weaning date). Bars represent least squares means ± SE.

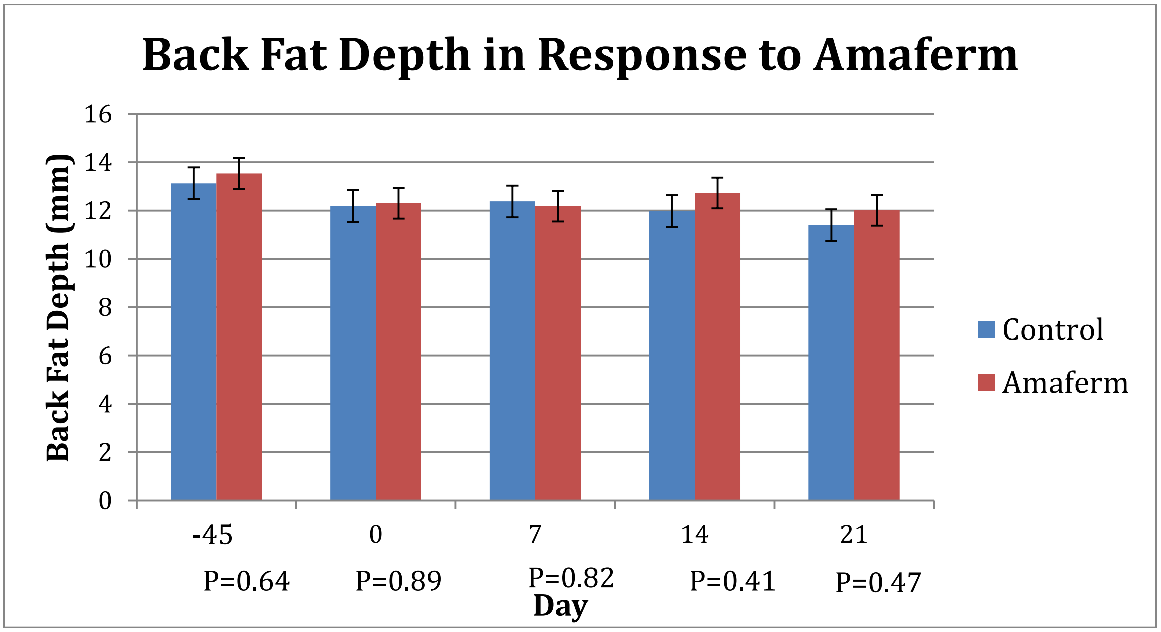

Figure 3: Comparison of back fat depth measured in mm between control and Amaferm supplemented sow diets from day 70 of gestation (-45) and day 21 (weaning date). Day 0 is the day of farrowing. Bars represent least squares means ± SE.

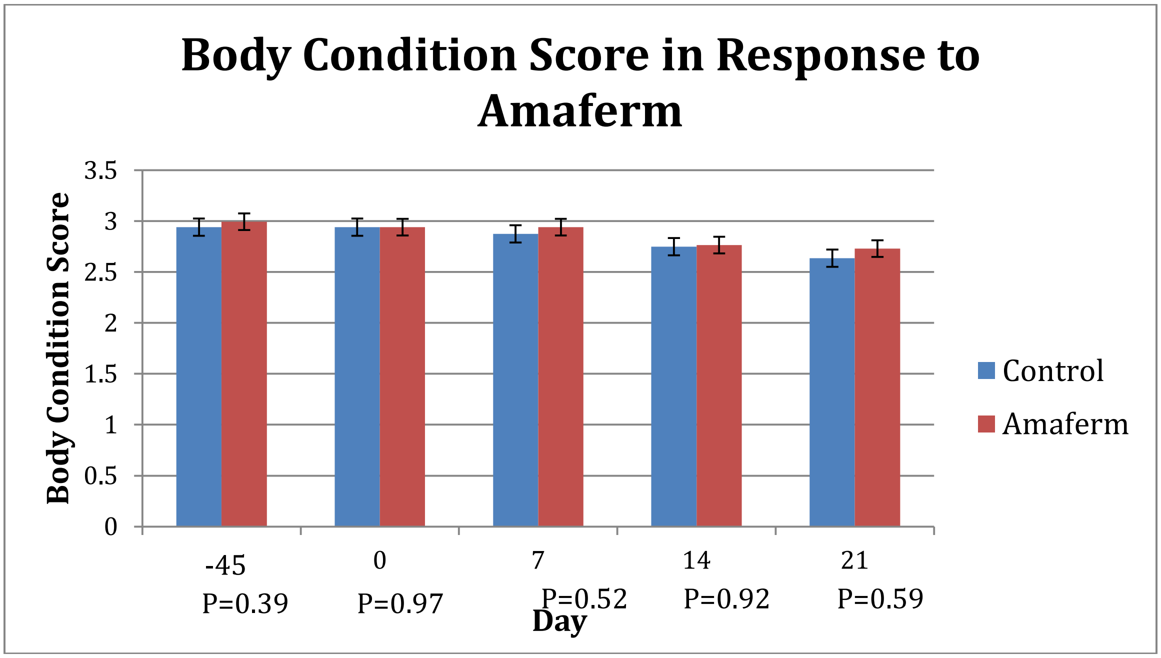

Figure 4: Comparison of body condition score between control and Amaferm supplemented sow diets from day 70 of gestation (-45) to day 21 (weaning day). Day 0 is day of farrowing. Body condition score was measured on a scale of 1-5. Bars represent least squares means ± SE.

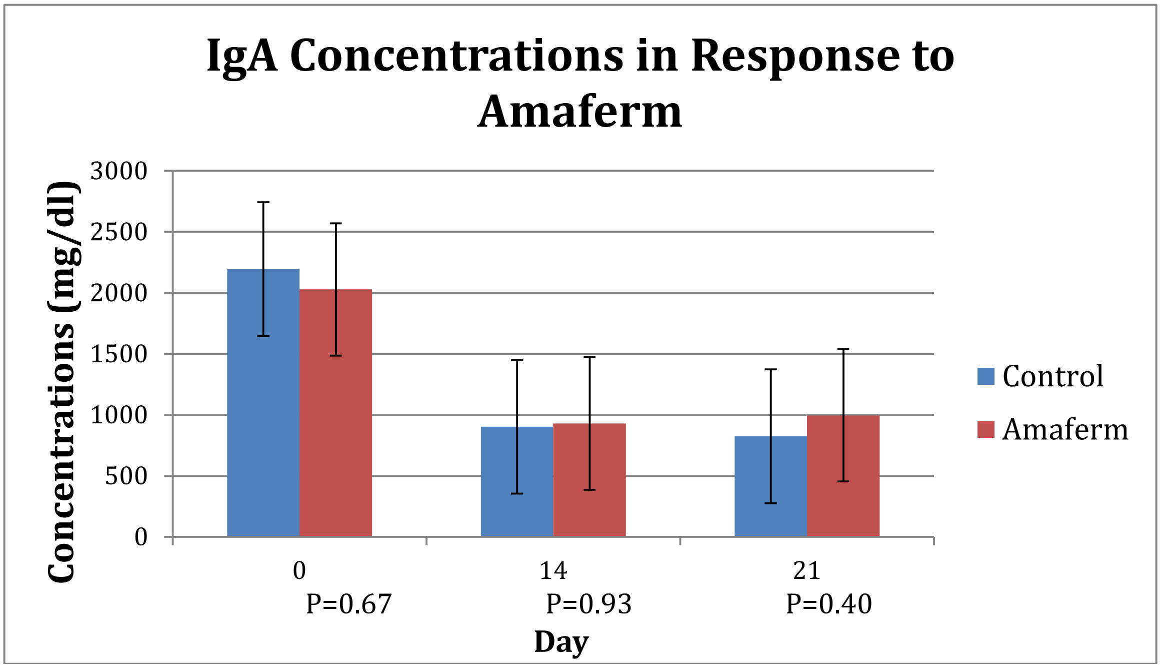

Figure 5: Comparison of IgA concentrations in mg/dl between control and Amaferm supplemented sow diets from day 0 (farrowing) to day 21 (weaning day). Day 0 represents colostrum, while day 14 and day 21 represents milk samples. Bars represent least squares means ± SE.

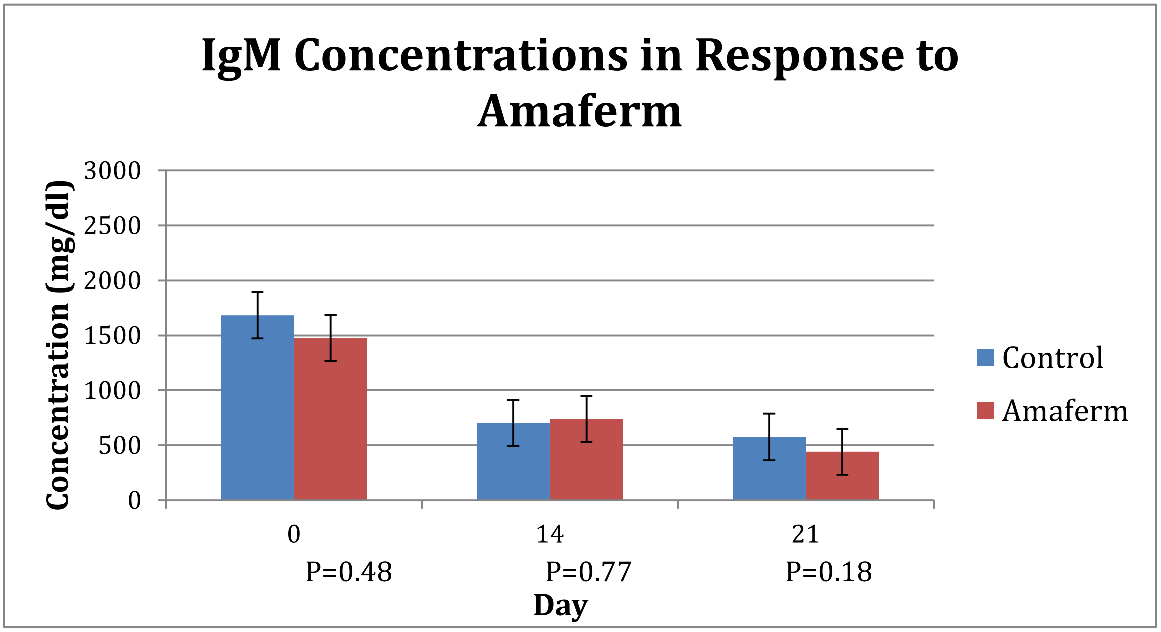

Figure 6: Comparison of IgM concentrations in mg/dl between control and Amaferm supplemented sow diets from day 0 (farrowing) to day 21 (weaning day). Day 0 represents colostrum, while day 14 and day 21 represent milk samples. Bars represent least squares means ± SE.

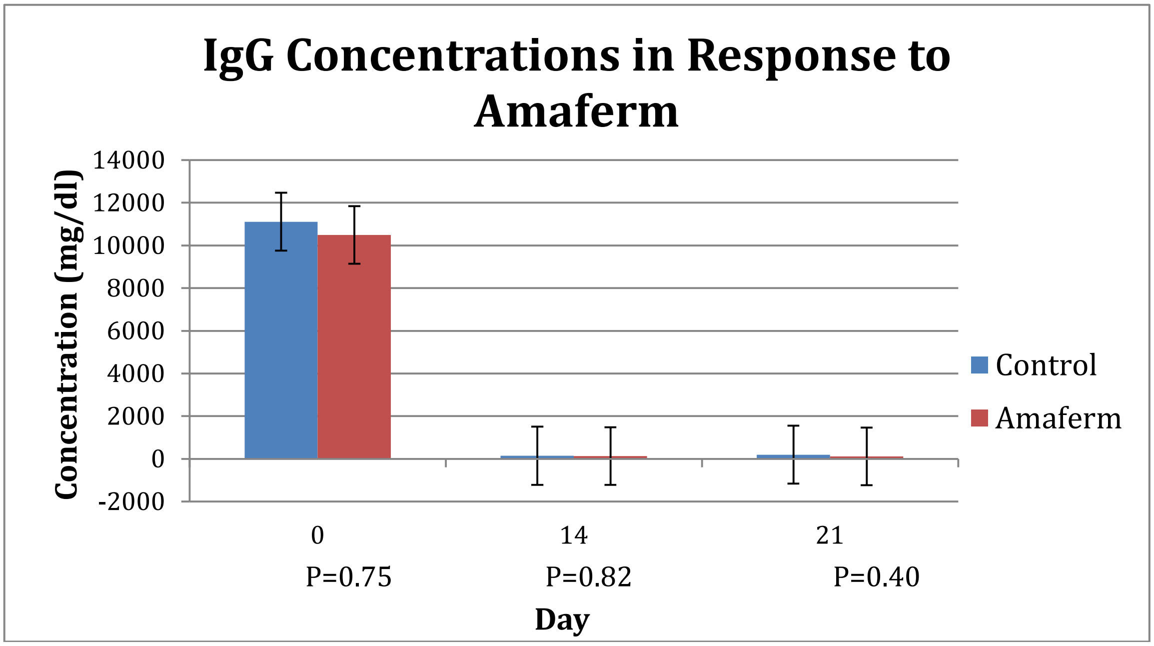

Figure 7: Comparison of IgG concentrations in mg/dl between Control and Amaferm supplemented sow diets from day 0 (farrowing) to day 21 (weaning day). Day 0 represents colostrum, while day 14 and day 21 represent milk samples. Bars represent least squares means ± SE.

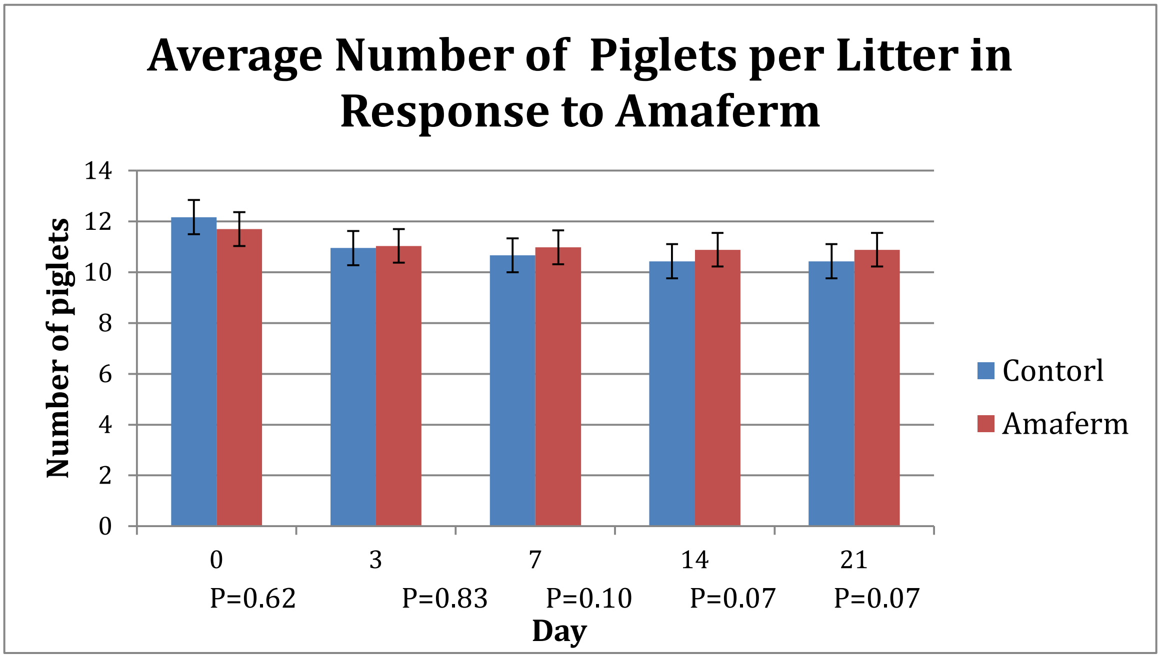

Figure 8: Comparison of average number of piglets per litter between Control and Amaferm supplemented sow diets from day 0 (farrowing) to day 21 (weaning day). Bars represent least squares means ± SE.

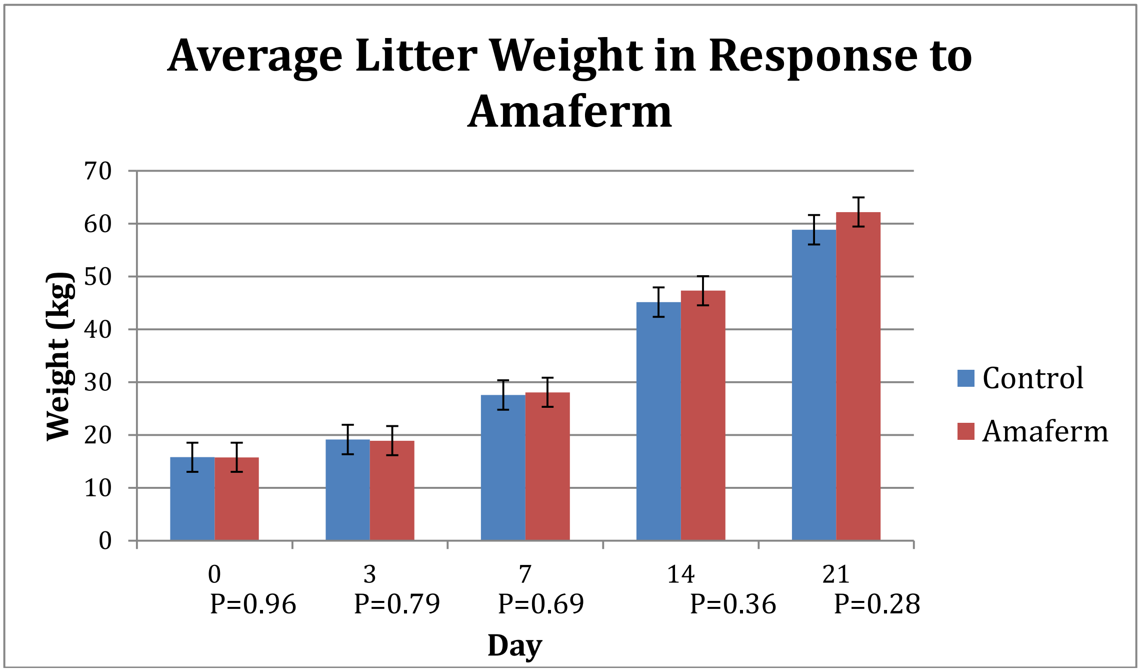

Figure 9: Comparison of the average weight of the litter of piglets (kg) for Control and Amaferm supplemented sow diets from day 0 (farrowing) to day 21 (weaning day). Bars represents least squares means ± SE.